Soils in Forest Management

Presentation to the High Level Forestry Pubic Advisory Group, November 15, 2011 in High Level, Alberta

The Forest

- Covers 60 percent of the landbase of Alberta (Green Area; ~ 38 million hectares)
- ~27,500,000 hectares of industrial forest

Alberta Forest Industry

- Forest Industry contributes ~ $8.4 billion to the GPP of Alberta (ref: AFPA statistic, 2007)
- Forest Industry provides ~54,000 jobs (24,195 primary sector; 24,490 secondary sector) (ref: AFPA statistic, 2007)

Alberta Forest Industry

- Significant investment in infrastructure and mills (tenures > 20 years)

Harvest Operations

Harvest Operations

Harvest Operations

Reforestation Operations

Implication

Given that:

- Forestry is very important to the economy of Alberta
  (industrial forest almost fully committed to forest industry)
- Forest operations occur in all seasons
- Forest operations are highly mechanized

Then:

The implication is that forest soils are at risk of being negatively impacted through over-management and ignorance. Once ruined, soils are extremely hard to return to their "natural" productivity.

Operational Soil Management Risks

- Harvesting and silviculture operations can affect soil structure and processes
- Detrimental effects to soils to be monitored and corrected as encountered
- Proactive planning should be cognizant of detrimental soil effects and mitigation
  - In the text of an annual operating plan as a distinctive plan proposal
  - As a best practice

Operational Soil Management Risks

- Effects include:
  - Compaction
  - Displacement
  - Rutting
  - Mixing
  - Stream bed “restructure”
  - Material deposit in stream
  - Glazing

The Forest is renewable:

- Through natural processes

The Forest is renewable:

- Applied reforestation strategies

Consider the Soil First

- Soil is the only natural medium in which the majority of flora and fauna exist
- Soil takes thousands of years to develop into current structure, both physical and chemical
- Northern Alberta soils are very slow to develop compared to other areas

Consider the Soil First

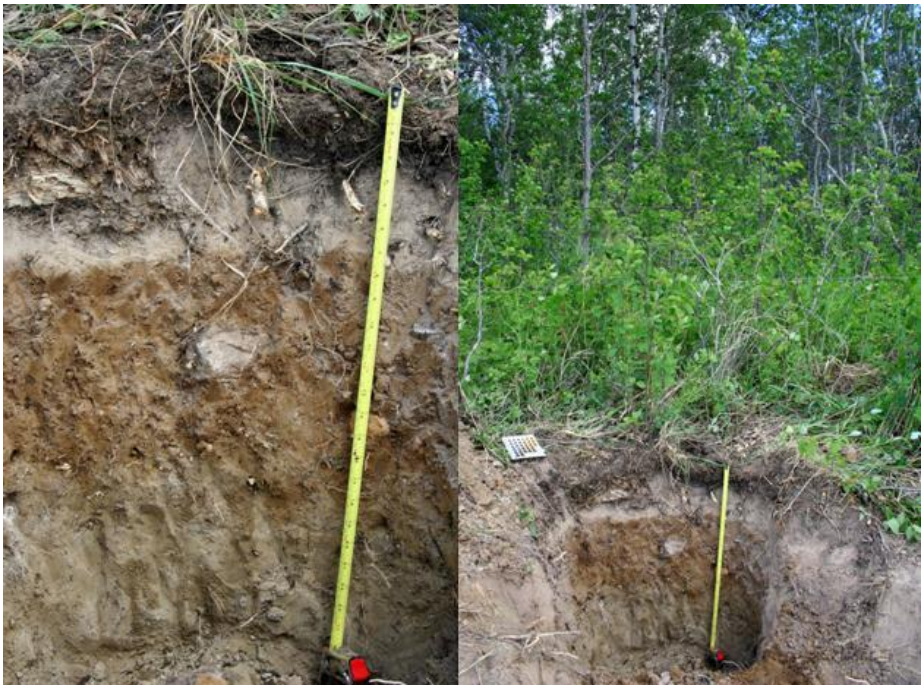
- Need to understand the soil structure on which operations will occur
- Basic soil science concepts as part of knowledge base to make informed decisions
- On-site, pre-harvest assessments….soil survey, soil pits…..
- Utilize previous ecological assessments

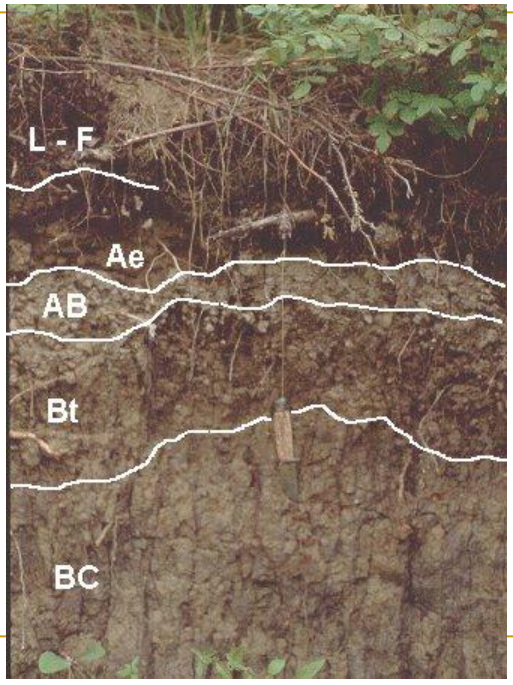
Soil Characteristics

- Composed of two different materials: Organic and Mineral
- Organic
  - Overlies mineral
  - Contains humic material (dead plant material)
  - Nutrients
  - Soil organisms
  - Insulates mineral
  - Holds periodic moisture

Soil Characteristics

- Mineral
  - Underlies organic
  - Usually formed in layers (sometimes consolidated)
  - Consists of coarse material, borne of rock and mineral breakdown
  - Unique by texture and chemistry
  - Is the structure of the soil column
  - Holds moisture and soil water
  - Provides the stability to rooting plants and trees





Reforestation – The Objective

- Reforestation intended to achieve:
  - **Survival:** getting the desired species to regenerate on the cutover site and remain there until the mortality risk is reduced.
  - **Productivity:** having the desired species perform to the expectations of regenerated stand production, with a projection of that level of performance until rotation.

Categories of a Reforestation Strategy

1. Seed Collection, Extraction & Storage
2. Seedling Production
3. Genetics & Tree Improvement
4. Silviculture Prescription
5. Site Preparation
6. Establishing Regeneration
7. Stand Tending
8. Enhanced Forest Management (EFM)
   - Post reforestation period treatment
   - Crop planning

Soil Ecology

- Soil Aeration
  - Pore space (size, availability)
  - Available O_2
  - Aerobic versus Anaerobic
- Soil Drainage
  - Infiltration
  - Seepage
  - Soil Water (from below)
  - Flooding (standing water)

Soil Ecology

- Soil Temperature
  - Related to presence of soil water
  - Directly affects rooting activity
  - Soil organisms and rates of decay
- Soil Texture
  - Affects soil drainage
  - Soil rooting potential and root spread
  - Available nutrients

Soil Ecology

The Connections:

- Aeration, temperature, texture and drainage in various combinations determine the capacity to which a soil is productive.
- Aeration and temperature affect soil microbe activity. Soil microbes break down organic material, releasing ions of various nutrients.
- Soil texture (and material: organic versus mineral) affects cation exchange. A cursory expression of the nutrient potential of a soil.
- Soil temperature and level of aeration are affected by the level of soil water present.

Soil Ecology

- Drainage potential (the ability of a soil to hold water for a period of time) is affected by soil texture (coarse = well/rapidly drained = drier soil)
- A drier soil is likely warmer, and may be higher in nutrients available if soil microbes not limited by reduced temperatures.
- Coarser textured soil = well drained = warmer, but may have nutrients leached out faster, less nutrient potential

Soil Ecology

- Important to understand the relationships of the components of the soil dynamic
- Must be able to logically build a silviculture prescription with effective treatments
- Identify and utilize what a specific site has to offer to support reforestation strategies

Silviculture Prescription

- Identify observed and measured limitations to seedling survival and productivity:
  - Mottling/gleying = excessive soil water
  - Coarse texture = rapidly drained
  - Blocky B horizon = perched water
  - Fine texture = greater compaction effect
  - Thin duff development = low nutrient status (nutrient regime also determined from indicator species on site)

Silviculture Prescription

- Determine type of regeneration method that will work best for the species to be reforested
  - Planting
  - Artificial Seeding
  - Leave for Natural (suckering, seeding)

Silviculture Prescription

- Determine type of microsite desired
  - Mixed
  - Elevated
  - Natural (eg: straight plant)
  - Dragged
- Determine machinery best suited to achieving microsite desire with low risk to detrimental effects to soil

Silviculture Prescription

- Determine season with lowest risk to detrimental effects on soil from:
  - Operations to create desired microsite
  - Access of machinery to treatment site
- Deliver reforestation strategy and monitor as it develops
  - May wish to make changes on-the-fly
  - May have to avoid certain areas
  - Constant monitoring required

Anatomy of a Microsite

Advantage of site prepared microsite:

- Rooting zone:
  - Warming the soil
  - Drying the soil
  - Increase available O^2
- At surface:
  - Mixing the soil
  - Exposing mineral soil
  - Reduces effect of frost
  - Reduces the effect of competition

Anatomy of a Microsite

- Exposed mineral soil; friable
- Duff layer removed or mixed
- Elevated
- Inverted humic layer
- Ample soil capping (seedling stability)
- Shelter
- Trampling protection

Anatomy of a Microsite

Options with Soil Damage

- Decompaction
  - Ripper
  - Sub-soiler
  - Disking
  - Mounding
- Erosion Control
  - Grass-mixes and low brush plants

Options For Soil Damage Prevention

- Operate on frozen ground
- Low-ground pressure tires on machinery
- Wide pads on tracked vehicles
- Stream crossing structures or frozen snow-fills
- Terra mats
- Walk machinery on branches and boughs
- Wood chip road surface

Summary

- Soil is the most valuable natural medium in the forest, supporting the majority of the flora and fauna.
- Amongst others, the four main components of the soil dynamic are aeration, temperature, texture and drainage.
- The risk potential for negative effects to soil productivity remains high in a vibrant forest industry in Alberta, whose industrial forest land is almost totally committed.

Summary

- Must be aware of how a soil can be damaged, and what types of soils are at risk for what types of damage.
- Frost periods (frozen ground) can reduce the risk of soil damage from machinery
- Damaged soils might be rehabilitated, but may not reach their original productivity
- Soil productivity potential can be maintained if operations and precautions are diligently practiced.

Summary

Best Practices

- Ensure best information and knowledge of soil science available to practicing professionals
- Perform pre-harvest site assessments to identify soil characteristics and site limitations to plant survival and productivity
- Assess pre-harvest site nutrient regime (from indicator species, combined with soil development and drainage observations)
- Clearly understand your silviculture objective and the dynamic of the soil you are working with.
- Ensure season of operability suits the soil's capacity to handle harvest and reforestation machinery.

Summary

Soil is not just dirt.

It is a living medium in which the greater part of the earth's ecology relies for survival and continued productivity.


Thank you